DISSERTATION

CYTO-GENOTOXICITY ASSESSMENT OF SELECTED INDUSTRIAL EFFLUENTS AND WASTEWATERS DISCHARGED INTO KELANI RIVER, SRI LANKA USING PLANT AND FISH BASED BIOASSAYS

Submitted by

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ABSTRACT

Kelani River which receives a variety of industrial effluents is considered as the most polluted river in Sri Lanka. Industrial effluents being the extreme complex mixtures may pose deleterious ecological and human health impacts upon exposure. Despite, Kelani River is used as the main source of drinking water supply for the general public in the nearby metropolitan areas. The present study was aimed at assessing cyto-genotoxicity of selected treated industrial effluents and wastewaters discharged into the Kelani River using plant based (*Allium cepa* test systems) and fish based (*Oreochromis niloticus* erythrocytic micronuclei and nuclear abnormalities tests and comet assay) bioassays. Initially the bioassays were validated under tropical temperature conditions with selected inorganic and organic cyto-genotoxicants. Plant based bioassay was used for evaluating potential cyto-genotoxicity of selected heavy metals (Cd, Cr and Cu) at the Sri Lankan tolerance limit concentrations for the discharge of industrial effluents into inland surface waters. Further nine industry effluents with diverse industrial profiles were screened for potential cyto-genotoxicity with the plant based bioassay. Both plant and fish based test systems were applied for assessing cyto-genotoxicity hazard of treated effluents from two textile industries (T1 & T2), common wastewater treatment plant effluents from two industrial zones (InZ1 & InZ3) and two drinking water treatment plants (WT1 & WT2). The effluents were tested under undiluted and diluted (1:8) conditions. Moreover, cyto-genotoxicity of water samples from different steps of purification were also assessed using both bioassays. The effluents/surface waters were physico-chemically characterized using standard methods.

Of the three metals tested at the national tolerance limit concentrations for the discharge of industrial effluents into inland surface waters, Cu showed the highest cytotoxicity and metals in combinations displayed interactive cyto-genotoxicity ($P<0.05$) signifying the necessity of reviewing the tolerance limits of the heavy metals specified in the national regulations. Of the nine industrial effluents tested in the screening study based on plant bioassay, cytotoxicity was greatly exhibited by rubber industry effluents whereas genotoxicity was mostly displayed by textile industry effluents even though most of the tested physico-chemical parameters comply with the national tolerance limits. The overall hazard ranking system which was developed in the present study based on the cyto-genotoxic end points tested under both plant and fish based bioassays in multiple sampling events revealed that the cyto-genotoxic hazard of the tested effluents increase in the order, WT1< WT2 <T1<T2≈ InZ1 < InZ3 and WT1<WT2< InZ1< T2< T1≈ InZ3 for the undiluted and diluted (1:8) conditions respectively indicating the highest cyto-genotoxic hazards of the industrial zone and textile industry effluents discharged into Kelani River. This is the first comprehensive study on toxicity assessments of industrial waste discharged into Kelani River based on combinations of plant and fish based bioassays. The study provides strong scientific evidence for the urgent need of incorporating 'biological effect assessment' components complementary to conventional physico-chemical assessments relevant to the discharge of industrial effluents into inland surface waters in Sri Lanka considering ecological and human health. Recommendations for management strategies for the potential hazards pose by the industrial effluents discharged into the Kelani River are discussed.

Key words: Kelani River, cytotoxicity, genotoxicity, bioassays, industrial effluents